GAS TURBINE ENGINES

This invention relates to nozzles for gas turbine engines, and relates in particular to nozzles for variable pitch fan gas turbine engines.

In a variable pitch fan engine a fan delivers compressed air to a bypass duct formed between a cowling surrounding the fan (a fan cowl) and a core engine which drives the fan. The pitch of the fan blades may be varied to match the performance of the engine to the flight envelope of an aircraft in which it is installed. Thus for take off conditions the fan blades are set in coarse pitch and deliver the maximum amount of air through the bypass duct, for cruise conditions the blades are set to a finer pitch and deliver a lesser amount of air through the duct, and, on landing, reverse pitch is selected to reverse the direction of flow through the duct and exert a braking force on the aircraft. In such engines it is necessary to alter the cross-sectional flow area of the nozzle formed between the end of the fan cowl and the core engine to suit the pitch of the fan blades, and in particular this nozzle must act as an auxiliary intake for the engine when it is operating in the reversed pitch mode.

According to this invention a nozzle for a gas turbine engine comprises a cowl which defines the nozzle area and which includes a fixed portion and a portion axially movable in relation to the fixed portion to form an opening thereby defining additional nozzle area, and wherein the surfaces forming the opening are shaped to direct flow through the opening and to promote attachment of said flow to the surface of the cowl.

Preferably the gas turbine engine is a ducted fan engine in which the cowl defines the fan duct.

In one embodiment of the invention the gas turbine engine is a variable pitch fan engine.

In a variable pitch fan engine the opening in the fan cowl may serve as an intake when the fan is operating in the reversed thrust mode.

The size of the opening when operating as an intake may differ from its size when operating as a nozzle.

Thus, a nozzle for a variable pitch fan engine may comprise a fan cowl, which defines the nozzle area, and which includes a fixed portion, and a portion axially movable in relation to the fixed portion from a first position in contact with the fixed portion, to a second position, in which it is axially spaced therefrom, and which is further movable to a third position in which it defines an intake for the engine, when said engine is operating in the reversed pitch mode.

Also according to this invention a nozzle for a variable pitch fan engine comprises a cowl which defines the nozzle area and includes an upstream portion and relatively axially movable first and second downstream portions and wherein the second downstream portion is separable from the upstream and the first downstream portions to provide additional nozzle area and the first downstream portion is separable from the upstream portion to define an opening which provides additional intake area during reversed pitch operation of the fan.

An embodiment of the invention will now be described by way of example only with reference to the accompanying drawings wherein:

FIG. 1 is a longitudinal section through a variable pitch fan engine showing a nozzle constructed in accordance with the invention,

FIG. 2 is a half section through the nozzle of the engine of FIG. 1 shown in a first operating position,

FIG. 3 shows a second operating position of the nozzle of FIG. 1,

FIG. 4 shows a third operating position of the nozzle of FIG. 1,

FIG. 5 is a section on the line I—I of FIG. 1,

FIG. 6 is a section on the line II—II of FIG. 1,

FIG. 7 illustrates the sealing of the nozzle of the engine of FIG. 1,

FIG. 8 shows a first operating position of an alternative embodiment of the invention,

FIG. 9 shows a second operating position of the embodiment of FIG. 8, and,

FIG. 10 shows a third operating position of the embodiment of FIG. 8.

In FIG. 1 a gas turbine engine **11** is shown attached by a pylon **12** to a wing **13** of an aircraft (not shown). The engine comprises a fan cowl **14** which surrounds a fan **15** and has a fixed upstream portion and an axially movable downstream portion **20.** The pitch of the fan blades may be varied by means of a pitch change mechanism **16,** the fan being driven by a core engine **17** and delivering air to a bypass duct **18** formed between the fan cowl and the core engine.

The area of the nozzle formed by the rear part of the fan cowl and the core engine may be altered by translating the movable portion **20** of the fan cowl rearwards. Preferably, this movable portion forms a complete annulus as, in this way, the strength necessary to contain the gas pressures acting on the portion may readily be achieved by a light structure.

The annulus is translated rearwards along a guide rail **19** from a first position **21,** for cruise conditions, to a second position **22** for take-off conditions and to a third position **23** during reversed thrust.

In the first position **21** the annulus abuts the fixed portion of the fan cowl **24** so that its outer and inner surfaces **25, 26** respectively form a continuous profile with the outer and inner surfaces **27, 28** of the forward portion of the fan cowl.

FIGS. **2, 3** and **4** illustrate in more detail how the nozzle area variations alter the gas flow capacity of the nozzle. In FIG. **2** the annulus **20** is shown in the first position lying flush with the fan cowl **24.**

This section is taken at a different angle through the engine than the section of FIG. **1** and includes one of four screw jacks **31** used to translate the annulus. It will be seen that the fan cowl is lined with sound absorbing material **32.** An inflatable seal **33** prevents gas escaping through the space between the portions of the fan cowl when in the first position.

In FIG. **3** the screw jack has been extended to separate the two portions of the fan cowl sufficiently to permit some of the air to flow down the duct in the direction shown by the arrow **41** and for the remainder to pass in the direction **42** and out through the opening **40.** The surfaces **34** of the portions of the fan cowl that form the opening **40** are so shaped that the flow through them attaches to the outer surface **35** of the movable portion, thus no drag penalty is incurred by the flow breaking away from the fan cowl.

In FIG. **4** the screw jack has been further extended, and, with the fan operating in the reversed pitch mode, the direction of flow down the duct is reversed and the nozzle is now acting as an intake for the fan. It will be seen that additional "intake" area is achieved by the